IMAGING OF CHEST PAIN IN PREGNANCY AND POST-PARTUM

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I HAVE NO DISCLOSURES
LEARNING OBJECTIVES

- Demonstrate example of obligatory funny opening remark
- Review presentation of PE in pregnancy & post-partum (P&PP)
- Compare risks and benefits of diagnostic tools
- Illustrate optimal approach to evaluation for suspected PE in patients during P&PP
SCAPE OF PROBLEM

- Accounts for 20% of maternal deaths during pregnancy
- Elements of Virchow’s triad normally present
  - PE 55/100k pregnant women vs 20/100k nonpregnant
  - 421/100k in postpartum!!!
- Notoriously difficult to clinically diagnose
  - PE confirmed in 4-10% of suspected cases
  - 1/3rd likelihood of PE confirmed in nonpregnant patients
- Risk to mother AND fetus
  - Low test threshold
CLINICAL EVALUATION

- Nonspecific signs and symptoms (s/sx)
  - Dyspnea
  - Tachycardia
  - Leg swelling
  - Cough
  - Sweating

- Abnormal A-a gradient (≥15 mm Hg) observed in ~60%

CLINICAL EVALUATION

- Risk factors:
  - Thrombophilia – Odds Ratio (OR) 51.8
  - Antepartum immobilization – OR 7.7
  - Assisted reproduction – OR 4.3
  - Obesity (BMI > 25 kg/m²) – OR 1.8
  - Obesity + AP immobilization – OR 62.3

- No validated clinical prediction guidelines such as Wells and Geneva

CLINICAL EVALUATION

- Modified Wells Criteria
  - Clinical s/sx of DVT = 3
  - Alternative diagnosis less likely than PE = 3
  - Heart rate more than 100 = 1.5
  - Immobilization for 3+ consecutive days or surgery in previous 4 weeks = 1.5
  - Previous PE or DVT = 1.5
  - Hemoptysis = 1
  - Malignancy (tx in last 6 months) = 1

LOW RISK: 0-1    MODERATE RISK: 2-6    HIGH RISK: 7+

ROLE OF D-DIMER

- Sparse direct evidence
    - 37 women suspected of PE: VQ scans & D-dimer
    - Low prob PE → D-dimer levels 0.25–2.2 mg/l
    - High prob PE → D-dimer levels 0.31–1.74 mg/l
    - Sensitivity 73% & Specificity 15%
    - Negative likelihood ratio was 1.8

- Two case reports of false negative D-dimer tests
ROLE OF D-DIMER

- Indirect evidence (extrapolated from 3 DVT studies n=389)\textsuperscript{A, B, C}
  - Sensitivity 100%, Specificity 6-23%
  - Sensitivity $\rightarrow$ Confidence Intervals 68-100%
- One case report of false negative D-dimer (acute calf DVT)\textsuperscript{D}

ROLE OF D-DIMER

- Sparse direct evidence (1 VQ study n=37)
  - Sensitivity 73% & Specificity 15%
  - Two case reports of false negative D-dimer tests
- Indirect evidence (3 DVT studies n=389)
  - Sensitivity 100%, Specificity 6-23%
  - One case report of false negative D-dimer (acute calf DVT)

CURRENT EVIDENCE SUGGESTS D-DIMER NOT BE USED TO EXCLUDE PE IN PREGNANCY.
RISKS OF RADIATION

- Fetal Dose
  - Risks considered negligible at <50 mGy
  - No consensus as to whether V/Q or CTPA lower dose
  - Measured values for both: low & approximately equivalent
  - Similar to dose (0.5 – 1mSv) absorbed during gestation

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<th>Maternal Dose (WB Eff Dose mSv)</th>
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<td>V/Q</td>
<td>0.32-0.74</td>
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RISKS OF RADIATION

- Fetal Dose
  - Risks considered negligible at <50 mGy
  - Therefore Rad and NM exams that provide significant dx information should not be withheld
    - NRCP, ICRP, ACR, ACOG

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- Maternal Dose
  - V/Q << CTPA
  - Estimated risk: lung & breast cancers most likely to cause radiation-induced cancer mortality
### RISKS OF RADIATION

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- **Maternal Dose**
  - **CTPA**: 10 – 60 mGy
  - **V/Q**: 0.98 – 1.07 mGy
  - **Breasts**: 10 – 60 mGy
  - **Lungs**: 40 mGy


^ Br CA 13.6%
^ Lung CA 27%
RISKS OF CONTRAST

- **Fetus**
  - **Iodinated Contrast Agents**
    - No observed teratogenic effects
    - Hypothyroidism?: normal thyroxine levels in neonates of 344 pregnant women who underwent CTPA (Bourjeily et al, Radiology 2010)
  - **Gadolinium Contrast Agents**
    - Observed teratogenic effects in animal studies at markedly high doses and/or for extensive periods of exposure
    - No adverse effects in limited number of human observational studies
    - FDA Category C – Risk not excluded.
ROLE OF ULTRASOUND

- General population with suspected PE, prevalence DVT 9–12% when PE prevalence 20–36% (# to test = 11)
- In pregnant pts with suspected PE, DVT prevalence 3–6%
- Likelihood of positive US increases 4-fold with s/sx of DVT
ROLE OF ULTRASOUND

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IN PREGNANT WOMEN WITH SUSPECTED PE & SIGNS/SYMPTOMS OF DVT, PERFORM BILATERAL LE VENOUS US. IF POSITIVE ➔ TX, IF NEGATIVE ➔ FURTHER TESTING.
SIGNS & SYMPTOMS OF DVT
- UNILAT LEG SWELLING (2+CM>NML)
- PAIN WITH DEEP PALPATION
- LEFT SIDE SX
- 1ST TRIMESTER

DX APPROACH TO SUSPECTED PE IN P&PP

S/SX OF DVT

BILAT LE VENOUS US

TREAT

OTHER TEST
ROLE OF CXR

- No radiographic findings sensitive or specific for PE
- Abnormal features caused by PE include atelectasis, effusion, pulmonary infarct, regional oligemia
- CXR normal >50% pregnant patients with proven PE
- Normal in >90% of all pregnant patients with CP
- CXR may identify other pulmonary disease such as pneumonia, pulmonary edema, lobar collapse, pneumothorax
ROLE OF CXR

- Normal CXR predictive of definitive V/Q result in 90% of pregnant women with suspected PE
- Cahill et al, Obstet Gynecol 2009; 114
  - 304 pregnant and postpartum women with suspected PE
  - Patients with normal CXR significantly more likely to obtain diagnostic result with V/Q (94%) than CTPA (70%)

**CXR SHOULD BE 1ST RADIATION-ASSOCIATED PROCEDURE IN IMAGING WORK-UP OF SUSPECTED PE DURING PREGNANCY**
ROLE OF CXR

CXR SHOULD BE 1st RADIATION-ASSOCIATED PROCEDURE IN IMAGING WORK-UP OF SUSPECTED PE DURING PREGNANCY

- Wagner S. Obs & Gyn 2017;129(5)
  Impact of pregnancy on w/u for PE in ED

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<th>NONPREGNANT</th>
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<tr>
<td>#</td>
<td>174</td>
<td>4660</td>
</tr>
<tr>
<td>CP</td>
<td>52%</td>
<td>85%</td>
</tr>
<tr>
<td>SoB</td>
<td>26%</td>
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DX APPROACH TO SUSPECTED PE IN P&PP

S/SX OF DVT

+ BILAT LE VENOUS US

- CXR

+ TREAT
ROLE OF VQ SCINTIGRAPHY

- Scarsbrook et al, Eur Radiol 2007; Shahir et al, AJR 2010
  - N=192 Nml/VLP $\rightarrow$ NEG(-) for PE $\rightarrow$ 186
  - Preg Pts LP/Intermediate $\rightarrow$ Non Diagnostic
  - Q only Hi Prob $\rightarrow$ POS(+) for PE

https://nucradshare.com/Lung.html
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- N=192
  - Nml/VLP $\rightarrow$ NEG(-) for PE
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  - Hi Prob $\rightarrow$ POS(+) for PE
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  - Only
  - 1

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- Scarsbrook et al, Eur Radiol 2007; Shahir et al, AJR 2010
- N=192
  - Nml/VLP $\rightarrow$ NEG(-) for PE
  - Preg Pts: LP/Intermediate $\rightarrow$ Non Diagnostic $\rightarrow 5$
  - Q only: Hi Prob $\rightarrow$ POS(+) for PE
ROLE OF VQ SCINTIGRAPHY

- Scarsbrook et al, Eur Radiol 2007; Shahir et al, AJR 2010
- N=192
  - 186 = Nml/VLP $\rightarrow$ 96.8% $\rightarrow$ ALL NO PE @ FU
  - 5 = LP/Intermed Prob $\rightarrow$ 2.6%
  - 1 = HiProb

ALL HAD NML CXR
ROLE OF VQ SCINTIGRAPHY

- Scarsbrook et al, Eur Radiol 2007; Shahir et al, AJR 2010
  - N=192
    - 186 = Nml/VLP → 96.8%
    - 5 = LP/Intermed Prob → 2.6%
    - 1 = HiProb
  - 100% negative predictive value in all completed studies (n=191) with results other than high probability

- Definitive V/Q results (hi prob, very low prob, normal) in 75–94% of pregnant women with suspected PE (4 retrospective studies, N=404)
  - 91% Definitive vs 9% Nondiagnostic

NML CXR
ROLE OF VQ SCINTIGRAPHY

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  → 91% Definitive vs 9% Nondiagnostic

**IN A PREGNANT WOMAN WITH SUSPECTED PE & NORMAL CXR, RECOMMEND V/Q SCAN AS NEXT IMAGING RATHER THAN CTPA**
ROLE OF VQ SCINTIGRAPHY

- Definitive V/Q results (hi prob, very low prob, normal) in 75–94% of pregnant women with suspected PE (4 retrospective studies, N=404)
  → 91% Definitive vs 9% Nondiagnostic

**IN A PREGNANT WOMAN WITH SUSPECTED PE & INCONCLUSIVE V/Q, SUGGEST FURTHER DX TESTING RATHER THAN CLINICAL MANAGEMENT ALONE**
DX APPROACH TO SUSPECTED PE IN P&PP

S/SX OF DVT

BILAT LE VENOUS US → S/SX OF DVT

CXR

CTPA

V/Q SCAN
DX APPROACH TO SUSPECTED PE IN P&PP

IF INCONCLUSIVE V/Q, SUGGEST FURTHER DX TESTING RATHER THAN CLINICAL MANAGEMENT ALONE
ROLE OF CT PULM ANGIO

- Shahir et al, AJR 2010 – CTPA vs Q
  - Retrospective management study (n=106)
  - Negative predictive value 99%/100%
- Clinically significant incidental findings in 13% C, D
- Technically inadequate studies in 6-36% A-E (N=324)
  - 4 studies → 17-36%

^ Blood Volume
^ Cardiac Output
Elevated Diaphragms

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- Abnml CXR: Non Dx rate V/Q scan (40%) > CTPA (16%)

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IN PREGNANT WOMAN WITH SUSPECTED PE & ABNORMAL CXR, RECOMMEND CTPA AS NEXT IMAGING TEST OVER V/Q SCAN
ROLE OF CT PULM ANGIO

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  - Clinically significant incidental findings in 13%
    - NO: PTX, Aortic Rupture/Aneurysm/Dissection
ROLE OF CT PULM ANGIO

- Clinically significant incidental findings in 13% \(^A, B\)
  - PNA 5-7%
  - Pulm Edema 2-6%

ROLE OF CT PULM ANGIO

- Clinically significant incidental findings in 13%
  - PNA 5-7%
  - Pulm Edema 2-6%
  - 64% abnormalities also identified on CXR


DX APPROACH TO SUSPECTED PE IN P&PP

S/SX OF DVT

BILAT LE VENOUS US

CXR

US CTPA

CTPA

V/Q SCAN

TREAT

STOP

TREAT
TREATMENT OF PE IN PREGNANCY

- We can make a difference!!!
- Untreated PE $\rightarrow$ 18-30% mortality $^A$
- Treated PE $\rightarrow$ 8% mortality
- Anticoagulation TOC in hemodynamically stable pt
- Low molecular weight heparin SQ $^B,C$
- Tx: 3 months and at least 6 weeks postpartum


ASSUMPTIONS

- All studies equally available
- Rapidity to diagnosis not critical
- Equivalent local expertise for all tests

- In absence of evidence showing clear superiority of one test over another, ultimate choice of tests will depend on preferences of patient and managing physician


Committee on Obstetric Practice. *ACOG* Committee opinion: Guidelines for diagnostic imaging during pregnancy and lactation. *Obs Gyn* 2017;130(4):e210-216


CLINICAL SCENARIO 1

1. The initial imaging study for pregnant and post-partum patients with suspected PE depends on what factor?

   a. Signs/symptoms of DVT
   b. D-dimer results
   c. Pregnant versus postpartum status
   d. Renal function
2. What is the first radiation-associated imaging modality used in the assessment of suspected PE in pregnant patients?

a. CXR
b. VQ scan
c. CTPA
d. DSA
CLINICAL SCENARIO 3

3. Which female patient population has the highest prevalence of PE?

a. Child bearing age women
b. Pregnant women
c. Post-partum women
CLINICAL SCENARIO 4

4. Per PIOPED, what is maximum likelihood of PE (%) in the setting of a low-probability VQ scan?

A. 10%
B. 20%
C. 50%
D. 80%
5. The standard of care for acute submassive PE in pregnant and post-partum women is which treatment?

A. Sequential compression devices (SCDs)
B. Anticoagulation
C. Thrombectomy
D. Induction of labor or caesarian section
Thank you